

On the Observation of Sun and Stars made in some British Stone Circles. Third Note.—The Aberdeenshire Circles.

By SIR NORMAN LOCKYER, K.C.B., F.R.S., Hon. LL.D., Hon. Sc.D., Director
Solar Physics Observatory.

(Received January 15,—Read January 30, 1908.)

In previous communications to the Royal Society,* I have shown that if we consider the sun's declination at the quarter-days of the May year and at the solstices, and also the changes due to precession in the places of five or six of the more conspicuous stars visible, at any epoch, in these latitudes we are able to account for the alignments investigated in the stone monuments in Cornwall and Devon.

The present paper deals with a special class of circles in Aberdeenshire in which the method of indicating alignments shows a striking difference. The Cornish method was that still set out in the instructions for the erection of the Gorsedd circle of the Welsh Eisteddfod,† the sighting, or directing, stones were placed some distance outside the circle. In Aberdeenshire the method employed was to place a long, recumbent stone generally between two of the upright stones of the circle itself and to obtain the direction of the rising sun or star by sighting across the circle at right angles to the length of the recumbent stone.

In every case yet investigated, with two exceptions where there had been disturbance, I have found this sight-line to have had apparently the same general direction, and therefore the same astronomical use as in Cornwall.

In the tables, I give the name of the circle, followed by the magnetic azimuth of the direction of the longest surface of the recumbent stone towards E., as determined with a Barker clino-compass. Deducting $18^{\circ} 45'$ —the westerly variation of the compass in Aberdeenshire at the present time—from this, we obtain the true azimuth, which is given as reckoned from N. through E. On deducting 90° from this, we get the line at right-angles, which I believe to be the sight-line for which the circle was erected; of this the true azimuth is also given.

The local conditions often militate against the exact determination of the elevation of the horizon, but, where possible, I measured it approximately with the compass-clinometer and state the results.

* 'Roy. Soc. Proc.,' vol. 76, A, p. 177, March 15, 1905, and vol. 77, A, p. 465, March 19, 1906.

† See 'Nature,' vol. 76, p. 9.

The alignments are limited to four regions with about the following azimuths :—

N. 43° E. The sunrise at the summer solstice.

N. 59° E. The sunrise in May.

N. 5° — 30° E. Clock-star observations.

True north.

I take them in this order.

Summer Solstice.

I found that three circles were probably erected to watch the summer-solstice sunrise. The following table (I) shows the results of the measures. With these circles accurate measurement is a difficult matter and, as the determination of the date of erection from the variation of the obliquity of the ecliptic entails very precise measures, I content myself with pointing out that the declinations are solstitial and that they agree, in the mean, with the values previously obtained for the English solstitial circles.

Table I.

Circle at—	Azimuths.			Elevation of the horizon.	Declination N.
	Magnetic, mean of observations.	True, from N. through E.	True, at right-angles across circle.		
Sunhoney	° / *	° / —	° / N. 52 35 E.	° 4	° / 22 25
Midmar	155 15	136 30	46 30	2	23 15
Stonehead (Insch)... ..	146 15	127 30	37 30	1	25 41
Mean of above...	...	...	...	...	23 47

* At Sunhoney, as the recumbent stone was curved and irregular, it was simpler to measure directly across the circle at right-angles to the length of the recumbent stone; the magnetic azimuth thus obtained was $71^{\circ} 20'$.

Table II.—English Monuments, for Comparison.

Monument at—	Alignment.	Azimuth (true).	Elevation of the horizon.	Declination N.
Stonehenge	Direction of avenue from circle	° / N. 49 34 E.	° / 0 35	° / 23 54
Stanton Drew	Great circle to N.E. circle	51 0	1 5	23 49
Boscawen-Un	Centre of circle to fine menhir	53 30	1 15	22 58
Tregeseal	Centre of circle to holed stones	53 20	1 15	23 2
Longstone (Tregeseal)	To Mên-an-Tol.....	50 30	0 34	24 7
Mean of above ...	...	...	...	23 34

May-year. Sun's Declination 16° 20' N. (May 6, August 8).

Two of the circles, as shown in Table III, were apparently erected for the observation of sunrise at the commencement of the May-year. A comparison of the results given in this table with those given in Table IV shows how well they agree, in the mean, with the results obtained from the previous investigation of May-sun alignments in Cornwall and Devon.

Table III.

Circle at—	Azimuths.			Elevation of the horizon.	Declination N.	Dates.	
	Magnetic mean of observations.	True, from N. through E.	True, at right-angles across circle.			May.	August.
Berry Brae	170	151 15	N. 61 15 E.	1	15 30	May 3	Aug. 11
Hatton of Ardoyne ...	166	147 15	N. 57 15 E.	$\frac{1}{2}$	17 8	May 9	Aug. 5
Mean of above.....	...	...	...	(assumed)	16 19	May 6	Aug. 8

Table IV.—May-year Alignments in England, for Comparison.

Monument at—	Alignment.	Azimuth.	Elevation of horizon.	Declination N.	Dates.	
					May.	August.
Boscawen-un	Circle to two large menhirs	N. 66 50 E.	1 0	14 55	May 1	Aug. 13
Merry Maidens	Circle to Fougou	N. 64 0 E.	0 30	16 21	May 6	Aug. 8
Tregeseal	Circle to Longstone	N. 67 20 E.	1 18	15 3	May 2	Aug. 13
Longstone (Tregeseal)	To W. Lanyon Quoit	N. 67 0 E.	0 0	14 3	April 29	Aug. 16
Down Tor	Direction of avenue	N. 67 0 E.	0 30	14 23	April 30	Aug. 15
St. Cleer	Holy well to Trevethy cromlech	N. 64 0 E.	0 30	16 21	May 6	Aug. 8
Lesquoit cromlech	Orientation of cromlech ...	N. 64 0 E.	1 30	16 55	May 8	Aug. 6
Druids' Altar (Pawton)	" " ...	N. 64 0 E.	1 30	16 55	May 8	Aug. 6
Mean of above.....	...	...	...	15 38	May 4	Aug. 10

In addition to those given in Table IV, I have found* that Lukis† and Borlase‡ give plans of a number of cromlechs in Cornwall which appear to be oriented to the May sun.

* See 'Nature,' No. 1987, vol. 77, p. 84, November 28, 1907.

† 'The Prehistoric Stone Monuments of Britain—Cornwall.'

‡ 'Antiquities of Cornwall.'

They are as follows :—

Cromlech.	Authority.	Azimuth.
		°
Lanyon Quoit	Borlase; plate xxi ...	N. 66 E.
Mulfra Quoit	Lukis; plate xix	N. 63 E.
Chywoone Quoit	Lukis; plate xx	N. 64 E.
Zennor Quoit	Lukis; plate xxi	N. 64 E.
Three Brothers Grugith ...	Lukis; plate xxiii ...	N. 64 E.
Mean of above ...	... ..	N. 64° 12' E.

Assuming an elevation of the horizon between $\frac{1}{2}^{\circ}$ and 1° , this mean value is the exact azimuth of the May sunrise in Cornwall.

Clock-stars.

Table V contains the results for 15 circles, in each of which the observation of a clock-star* appears to be indicated. From the data in the table, the declinations of the stars were determined from a curve connecting azimuth and declination, for different elevations of the horizon, for the general latitude of 57° N.; consequently they are not final, but are sufficiently accurate for a preliminary discussion.

Between 2000 B.C. and 1 B.C. Arcturus and Capella were the only first-magnitude stars to come within the declination range shown in the table, and, as my results show that they were used as clock-stars in Cornwall and Devon,† I consider that the evidence in their favour warrants the assumption that one of them was used as a clock-star by the circle-builders of Aberdeenshire, therefore I give the dates for Arcturus and Capella respectively.

* See 'Roy. Soc. Proc.,' vol. 77, pp. 465—466.

† 'Roy. Soc. Proc.,' *loc. cit.*

Table V.

Circle at—	Azimuths.			Elevation of the horizon.	Declina- tion N.	Dates B.C.	
	Magnetic mean of observations.	True, from N. through E.	True, at right-angles across circle.			Arcturus.	Capella.
	° /	° /	° /	°	° /		
Braehead Leslie	132 20	113 35	N. 23 35 E.	1½	30 58	250	2000
Leylodge	123 0	104 15	N. 14 15 E.	0	31 18	330	1940
Loudon Wood	120 40	101 55	N. 11 55 E.	0	31 38	370	1890
Tomnagorn	124 0	105 15	N. 15 15 E.	½ ?	31 42	390	1860
Wanton Wells	130 30	111 45	N. 21 45 E.	2	31 52	420	1830
Old Keig	138 0	119 15	N. 29 15 E.	4	31 55	430	1820
South Fornet	116 48	98 3	N. 8 3 E.	0	32 4	450	1800
Nether Boddam	130 0	111 15	N. 21 15 E.	2	32 8	460	1790
Aikey Brae	113 0	94 15	N. 4 15 E.	0	32 18	500	1760
Castle Fraser	129 36	110 51	N. 20 51 E.	2½	32 42	570	1680
New Craig	129 34	110 49	N. 20 49 E.	2½	32 43	570	1680
Loanhead of Daviot ...	116 45	98 0	N. 8 0 E.	1	33 14	660	1580
Kirkton of Bourtie.....	123 30	104 45	N. 14 45 E.	2½	33 57	770	1460
Cothie Muir	127 40	108 55	N. 18 55 E.	4	34 42	920	1300
Eslie the Greater	113 30	94 45	N. 4 45 E.	2½	35 5	980	1230

Comparing these results with those given for the English circles in the previous paper,* the similarity of the object in view, and the means of attaining it, are, I think, obvious.

The mean date for Arcturus is about 600 B.C., and for Capella about 1600 B.C. Collateral evidence suggests that Arcturus was the clock-star employed, but more observations and enquiries are necessary to determine finally this point.

Due North Alignments.

In addition to the circles mentioned above, there are four in Aberdeenshire in which the alignments are due north. They are respectively situated at Dyce, Whitehill Wood, Raes of Clune and Candle Hill (Insch), and probably represent a later development when the observer's knowledge was so far advanced that he needed only the cardinal point in order to recognise the clock-stars which it was necessary for him to observe.

My best thanks are due to Dr. Angus Fraser, Aberdeen; Mr. Ritchie, Port Elphinstone; Mr. Braid, Durris; Rev. D. Forrest and Mr. Ainslie, Mintlaw; and Colonel Smith and Mr. J. Graham, Callander, Insch, who assisted me in many ways in the different localities. Mr. W. E. Rolston, F.R.A.S., one of my staff, has computed the declinations and assisted in the preparation of this paper; the dates corresponding with the declinations involved have been taken from tables furnished by Mr. J. N. Stockwell, of Cleveland, U.S.A.

* 'Roy. Soc. Proc.,' vol. 77, pp. 467—468, March 19, 1906.